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ELECTRICITY.—*A determination of the international ampere in absolute measure.* E. B. ROSA, N. E. DORSEY and J. M. MILLER, Bureau of Standards.

The absolute unit of current in the electromagnetic system is defined in terms of the magnetic field which it produces. Hence we can measure current in absolute units by measuring the magnetic field due to the current, or by measuring the ratio between this field and some other field which is measurable, as, for example, the earth's magnetic field. The comparison may be made by means of the tangent galvanometer, and is often called the tangent galvanometer method.

Or, we can calculate the force of attraction between circuits carrying electrical currents, and determine the current by measuring the forces of attraction experimentally; this is called the electrodynamometer or current balance method. The potential energy of two circuits relative to one another is equal to $I_1 I_2 M$ where I_1 and I_2 are the strengths of the currents flowing in the two circuits and M is the flux of magnetic force through one circuit produced by a unit current in the other, that is, the mutual inductance. The force or torque between the two circuits tending to produce a displacement is measured by the rate of change of the potential energy. If the currents are constant, we have to consider, therefore, only the rate of change of the mutual inductance. If a particular displacement be represented by a change dx in the variable x, and the current is the same in the two circuits, the force $F = I^2 \frac{\partial M}{\partial x} = KI^2$, in which M has the dimensions of a line; hence $\frac{\partial M}{\partial x} = K$ is of zero dimensions, and is a function

only of ratios of the dimensions of the electrical circuit. To measure the current I, the force F must be measured and K must be determined. As to the method of measuring F and determining K, the various types of instruments differ.

The force or torque may be balanced by

(a) The elastic deformation of a wire or fiber.
(b) The gravitational attraction of the earth.

Then the torque or force must in turn be evaluated in absolute units.

K may be determined in three ways

(c) by measurements of the separate dimensions of the instrument.
(d) by comparisons of the instrument with some other instrument, the dimensions of which can better be measured.
(e) by measurements of the ratios of the dimensions which enter into K.

The accuracy attainable with the instrument depends upon the possible accuracy of these determinations.

The method (a) requires a direct determination of the force of restitution of the deformed body (generally a fiber) as it was used in the electrical measurements. The elastic after-effects shown by all material bodies introduce formidable difficulties.

The method (b) requires the measurement of a force by weighing, and the absolute value of the acceleration of gravity. The first is capable of extreme precision. An accurate determination of the second is very difficult, but results obtained with this method at different times and places can be very accurately compared by relative determinations of the acceleration of gravity and may be corrected at any time when the absolute value is determined to a higher degree of accuracy.

The determination of the constant K by the method given in (c) requires that the geometrical form of the apparatus be simple and the dimensions relatively large. Thus, the use of single layer coils is necessitated in general. The forces of attraction are usually small and can, therefore, be measured accurately only with difficulty. Furthermore, the constant is determined once for all and must be assumed to remain constant.

The method (d) allows the use of multiple layer coils and some other features which tend to give a high sensibility in non-absolute instru-

ments. The limitations of simplicity of form are, however, imposed upon a second apparatus with which the instrument itself is compared.

The method (c) allows the use of multiple layer coils and the resulting high sensibility. The ratios which enter into the constant of the instrument may be determined experimentally by methods which are comparative and allow an extreme precision. *The constant can be redetermined at any time.*

The Rayleigh type of current balance as used in this work embodies the advantages of the methods (b) and (c). It consists essentially of three multiple-layer coils of square cross-section; two large fixed coils and a smaller moving coil. All of the coils are coaxial and their planes are horizontal. In this work three pairs of fixed coils (50, 50 and 40 cm. in diameter) and three moving coils (25, 25 and 20 cm.) were used. The moving coil was suspended midway between the other two from one pan of a precision balance. The current was led in and out of the moving coil at the balance pan by means of fifty silver wires. These wires were slack and, on account of their fineness, did not interfere sensibly with the oscillations of the balance.

The force exerted upon the moving coil by the current in the fixed coils was weighed by means of the balance, as follows: The strength and the direction of the current in the coils were arranged so that the moving coil was pulled down by a force of about 3 g. This force and the weight of the moving coil were counter-balanced. Then the rest point a of the balance was determined. The current was then reversed in the fixed coils alone. The force then became a pull up instead of down, giving a change of about 6 g. A weight of 6 g. was put on one pan of the balance from which the moving coil was suspended, and very nearly compensated for the change in the force. Another rest point b was taken, the difference between a and b gave the difference between 6 g. and twice the electrical force upon the moving coil. The drift of the balance was eliminated by taking a series of the rest points a and b and plotting these against the time.

The determination of the force in absolute units required the knowledge of the absolute value of the acceleration of gravity. The value at the Bureau of Standards was determined in terms of the value at the United States Coast and Geodetic Survey by Mr. Wm. H. Berger of the Survey. Mr. G. R. Putnam of the Survey has connected the latter value with Potsdam by relative pendulum observations. Thus, the value at the Bureau of Standards has been referred to Potsdam, where, as the result of a long series of observations, the absolute value is

believed to be known to three parts in a million. On this basis, the absolute value at the current balance is 980.091 cm. per sec. per sec., and is probably correct to five or six parts in a million.

As seen before, the constant K is the rate of change of the mutual inductance with the displacement of one circuit in that direction in which we wish to determine the force. In the present case then, K is the rate of change of the mutual inductance of two coaxial circular coils, with the displacement of one coil in the direction of the common axis. The calculation can be simplified by first considering the actual coils to be linear circular circuits of radii equal to the mean radii of the coils. Then in various ways corrections for the finite sections of the coil can be applied. Maxwell has derived an exact formula for the mutual inductance of coaxial circles, and by differentiation obtained the expression for the force between them acting along the common axis. The force is given by the equation,

$$F = \frac{\partial M}{\partial B} = \frac{\pi B \sin\gamma}{\sqrt{Aa}} \left\{ 2F_\gamma - (1 + \sec^2\gamma)\, E_\gamma \right\}$$

where A and a are the radii of the two coaxial circles, B is the distance between their planes, $F\gamma$ and $E\gamma$ are the complete elliptic integrals of argument γ and

$$\sin\gamma = \frac{2\sqrt{Aa}}{\sqrt{(A+a)^2 + B^2}}$$

This expression for F can be put in a form where only the ratios $\frac{a}{A}$ and $\frac{B}{A}$ enter, hence F is a function of these ratios alone. Furthermore, at a certain distance B the force is a maximum, and the coils of the Bureau of Standards current balance were spaced so that this condition was satisfied. In this case the force becomes practically a function of $\frac{a}{A}$ alone; in other words is determined solely by the *ratio of the radii* of the two circles.

The determination of this ratio is then the important point in the determination of the constant of the instrument. It was determined experimentally by methods which admit of extreme accuracy. The principle of the method was identical with that given by Bosscha and used by Lord Rayleigh, but was modified to increase the precision. The coils to be compared were adjusted concentric and coplanar, with their planes vertical and in the magnetic meridian. Most of these adjust-

ments were made experimentally. Currents were then passed through the two coils in opposite sense and adjusted until the resultant magnetic field at the center was zero. This was indicated by a magnetometer needle, 2 mm. long. The ratio of the two currents which balance each other in this manner is equal to the inverse ratio of the "galvanometer constants" of the two coils, excepting for a small correction on account of the length of the needle. The ratio of the "galvanometer constants" gives the ratio of the two mean radii when the numbers of turns and the sectional dimensions of the coils are known.

The ratio of the current was measured in two ways which have been called the "potentiometer" and "shunt" methods, respectively. The first method consisted in a simultaneous measurement of the two currents by means of two potentiometers. The second method was employed in cases where, as designed, the coils had nearly the same galvanometer constants. In this method the two coils are joined in series in such a manner that the current flows through them in opposite sense. As used in this work both methods permitted an accuracy of about two parts in a million. The latter method, however, is somewhat the more accurate, considerably more rapid, and requires but one observer. In the table is given the results of a series of measurements of the ratio

DATE	RATIO	Δ
November 28	1.004596	3
	94	1
	95	2
	94	1
November 29	93	0
	89	4
	94	1
	93	0
	92	1
	95	2
	96	3
	92	1
	92	1
	91	2
	91	2
	94	1
December 2	93	0
	92	1
Mean	1.004593	1.4

of the galvanometer constants of a small fixed coil ($S1$) and a moving coil ($M3$). The values given have not been corrected for the length of the needle but have had small corrections applied for temperature variations and the heating effect of the measuring current.

The deviations from the mean in parts in a million are given in the third column. The average deviation is 1.4 parts in a million.

One of the features of the current balance which contributed very strongly to the attainment of a high accuracy is the water cooling system. In each of the fixed coils there is a channel back of the windings through which water can be circulated to carry away the heat generated by the electrical current. The supply of water was held at a constant temperature by means of a thermostat, thus maintaining the coils at a constant temperature and radius. Water circulated thru the fixed coils while the constant was being determined and when weighings of the force were being made. During the latter experiment the moving coil was surrounded by a copper water jacket thru which water from the same source was circulated. This served the purpose of carrying away the heat generated in the moving coil and also made constant the convection currents of air which were set up by the heating of the coil. The possible accuracy in the weighing was thereby considerably increased. By the method of weighing the constant lifting force of the currents of air was eliminated.

It was found important to measure the temperatures of the coils when being used. In the determination of the constant and the weighing, the temperature coefficient of the apparatus is zero since only the ratios of the dimensions enter; *provided* all portions are made of the same material and are at the same temperature. Since, however, heat is being generated in some portions and not in other portions, it is evident that the whole apparatus will not be at the same temperature and that the temperature differences will depend upon the quantity of heat generated in the various parts. Hence in this work the temperatures of the coils were measured by measuring the resistance of the windings and corrections were applied to bring all of the parts to the same temperature.

The rest points of the balance were read by means of a tele-

scope and scale and a small mirror mounted upon the central knife edge of the balance. The scale distance was about 2.5 meters. The accuracy of reading, therefore, was equivalent to that which would be obtained with a balance pointer 5 meters long. Thus, it was possible to have the balance very stable and of short period without decreasing the accuracy of the weighing.

Since the intensity of a current cannot be represented by a concrete standard, two expedients have been adopted to preserve the results of the absolute measurement of current. One is to determine the mass of silver deposited per second in a silver voltameter by a current of one absolute ampere, the other is to determine the electromotive force of a standard cell in terms of a standard of resistance and the absolute ampere. In this work the electromotive force of the Weston Normal cell at 20° C. was determined in terms of the international ohm and the absolute ampere. The authors have called the unit of electromotive force a semi-absolute volt. Also, the final result has been expressed in terms of the electrochemical equivalent of silver as determined by a large number of observations with two types of voltameters at the Bureau of Standards.

In the final work four combinations of coils were used, besides one which was not used in taking the mean, owing to a very slight uncertainty in its cross-sectional area, and the following results obtained:

COMBINATION	E.M.F. OF WESTON NORMAL CELL AN 22° C.	DEVIATION FROM MEAN PARTS IN A MILLION
M2, L3, L4	1.01822$_3$	5
M3, L3, L4	1.01820$_7$	21
M3, L1, L2	1.01822$_6$	3
M3, S1, S2	1.01823$_1$	12
Mean	1.01822$_3$	10

The conclusion is that the electromotive force of the Bureau of Standards concrete realization of the mean Weston Normal cell at 20° C. January 1, 1911, was 1.01822 semi-absolute volts. We believe that it is a conservative estimate to assign to the value given above a possible uncertainty due to all causes of two in

100,000 a quantity equal to twice the average deviation from the mean.

The value given by the combination *N*4 L3 *L*4, which was omitted from the mean, was 1.01825_2.

The weight to be attached to the final mean is considerably increased on account of the fact that three pairs of fixed coils, two large and one small, and two moving coils, of different radii, have been used. The possibility of the occurrence of appreciable constant errors in the work is thereby very much diminished.

Other observers in England, France and Holland have recently published results obtained by means of various types of instruments. When reduced to the same basis as used above, the values obtained are as follows:

1907	Ayrton, Mather and Smith	1.01818
1908	Janet, Laporte and Jouaust	1.01834
1908	Guillet	1.01812
1908	Pellat	1.01831
1910	Haga and Boerema	1.01825
Mean		1.01824 semi-absolute volts

The absolute value of the electrochemical equivalent of silver as obtained from the current balance of the Bureau of Standards and 159 silver deposits made by Rosa, Vinal and McDaniel in this laboratory with two types of voltameters is 1.11804 mg. per coulomb. The value adopted by the London Conference in 1908 was 1.11800. In other words, the international ampere as defined by means of the silver voltameter, as used at the Bureau of Standards, differs from the absolute ampere as realized there by means of the current balance by only four parts in 100,000.

When the absolute value of the international ohm is as accurately known as the absolute value of the international ampere is now known, the watt can be realized with high precision from the international watt, by applying as a correction the small difference between them. Even now the most accurate way of measuring energy or power absolutely is by means of electrical instruments.

ELECTRICITY.—*Resistance coils for alternating current work.* H. L. CURTIS and F. W. GROVER. Communicated by E. B. Rosa. To appear in the Bulletin of the Bureau of Standards.

In an ideal resistance coil for alternating current work two requirements need to be fulfilled in addition to those which are of importance in direct current work; viz, (1) the resistance must be independent of the frequency and (2) the phase angle must be zero. Many of the resistance coils in use at the present time do not even approximately fulfill these conditions. This paper attempts to set forth the principles which must be followed in the construction of satisfactory resistance coils for alternating current work, and to show how to apply them to the design and construction of several coils of different denominations.

The most important thing in the design of a coil whose phase angle is to be small, is to wind it in such a way that its inductance will be a minimum. However there are three other effects which need to be considered in the discussion of the phase angle; viz, (1) "skin effect," (2) capacity between the wires and (3) absorption in the dielectric between the wires. Each of these three causes also gives rise to a change in the effective resistance of the coil when used with different frequencies of alternating current.

Formulas have been developed for computing the value of the "skin effect." By means of these it can be shown that, with the size of wire usually used with coils having a resistance of one ohm and larger, the "skin effect" is in all cases negligible.

The capacity between the wires is in parallel with their resistance and inductance, and is distributed along their length. If R' is the effective resistance of a bifilar coil and θ its phase angle, then to a first approximation

$$R' = R\left\{1 + p^2 C\left(\frac{1}{3}L - \frac{2}{15}CR^2\right)\right\}$$

$$\tan\theta = \frac{p\left(L - \frac{1}{3}CR^2\right)}{R}$$

where R is the ohmic resistance of the coil, L its inductance, C, the capacity between the two wires, and p is 2π times the frequency. From this we see that $R'=R$ and $\theta=0$ only under the condition that both L and C are zero. While this cannot be accomplished in practice, yet if L is made as small as possible and if $L-CR^2=0$, then the phase angle will be zero and the change in resistance with frequency negligible. With coils having low resistance (less than 10 ohms) it is difficult to make the capacity large enough to make $L-CR^2=0$; but with coils of high resistance (1000 ohms and over) the capacity is usually much larger than it should be. Between these extremes satisfactory coils can be constructed without great difficulty.

In case alternating current is used, the absorption of a poor dielectric between the wires may produce an apparent leakage between turns where the direct current insulation resistance is sufficiently high. The magnitude of the effect of this upon the resistance of the coil will depend upon the resistance of the coil and upon its capacity as well as upon the absorption. Hence while it is entirely negligible for coils of low resistance, it becomes of importance in coils of high resistance. By so designing the coil that the capacity is small, it may usually be made negligible.

By keeping in mind the facts which are stated above, it has been found possible to design coils of denominations from 0.1 to 10,000 ohms in which the change in resistance is less than a part in a hundred-thousand for frequencies up to 3000 cycles per second, and in which the phase angle is not more than 3.5′ at 3000 cycles. For $\frac{1}{10}$-ohm, 1 ohm and 10 ohm coils strip manganin, wound in a bifilar manner is used. For 100-ohm coils a single-layer bifilar winding is satisfactory. For 1000-ohm coils fine 200-ohm single-layer bifilar coils are wound on an insulating spool (porcelain is satisfactory) and connected in series. For 10,000-ohm coils a special winding was devised. A tube of biscuit porcelain is cut along a diameter for two-thirds of its length. The winding is then made as follows: One turn is made with a single wire, then the wire passed thru the slit, and a turn made in the opposite direction. The wire is then passed thru the slit and the third turn is made in the same direction as the first, and the process repeated until sufficient wire is upon the spool.

PHYSICS.—*Helium tubes as light standards.* P. G. NUTTING, Bureau of Standards. Communicated by S. W. Stratton.

The investigation of the properties of electrically conducting gases with a view to their possible use as primary standards of luminous intensity has been in progress at the Bureau of Standards for the past six years. A summary of the results obtained is given below, this includes a report of a recent reproducibility test here given for the first time.

Of the available gases and vapors, helium is the only one emitting light of a suitable color and having reasonable lasting qualities. The light is of a yellowish white approximately that of the Hefner flame and of an old type carbon filament glow lamp. The useful life of a helium tube is from 5 to 100 hours depending on its construction and operation. The next best gases would be carbon dioxide and sulphur, but these emit a snow white light and disappear rapidly in carrying a current.

The form of tube found most suitable has a capillary portion of 2-mm. bore, 2-mm. thickness of wall and about 7 cm. long. The terminal bulbs are 35 mm. in diameter and spherical while the electrodes are aluminum disks 1 mm. thick and 25 mm. in diameter. Recent results indicate that possibly a slightly increased bulb diameter might give longer life to the tubes.

The relation between current and light emitted is very nearly linear over a wide range of intermediate currents, 10 to 35 m.a. Twenty-five milliamperes was chosen as the most suitable standard current.

The ratio of light emitted to internal energy, current times potential gradient, is not quite constant. The minimum watts per candle for a tube of 2-mm. base, namely, 3.8 w./c.p., occurs at a current between 25 and 30 m.a. Owing to the large and uncertain variations in the potential gradient and the difficulties in its precise determination, attention was directed toward expressing light in terms of current and bore rather than in terms of internal energy.

The light emitted by a helium tube as a function of current was later determined line by line for each of the six prominent spectrum lines. These all behave nearly alike, increasing with

current sensibly as does the total light. Helium shows no trace of any secondary spectrum in the visible region.

Neither the voltage nor frequency of alternation of the exciting current affect the light emission by a measurable amount. Voltages of 1, 2, 5 and 10 thousand were used and direct, alternating 60-cycle and 900-cycle current.

Gas density does not affect the specific light emission over a range from 3 to 8 mm. pressure provided the bore of capillary is not much over 2 mm. With 25 m.a. current through 2 mm.-bore, the light is sensibly independent of gas density from 3 to 8 mm. pressure. Chiefly for this reason these specifications and 4 to 7 mm. pressure were adopted for the standard tubes inasmuch as gas density is difficult to control and determine in such tubes.

The correction to the light emitted by a centimeter length of capillary for slight departures from 2 mm. in the bore was carefully determined. It is -0.010 c. p./cm. for each $+0.1$ mm. difference in bore from 2.00 mm.

A test for reproducibility was made on a set of forty tubes. The capillary portions of these tubes were specially prepared and selected by Baudin to secure the utmost possible uniformity of bore and wall and freedom from striations. The tubes were made up and filled at the Bureau of Standards.

Color reproducibility was determined by intercomparing the spectra of these tubes line by line with a spectrophotometer. The slight variations observed were well within the errors of observation.

Photometric observations on the mean horizontal candle power per centimeter length of capillary were made by four experienced observers. The computed probable error in the c. p./cm. for all observers and all the tubes was 0.16 per cent. The average deviation of the tubes from their mean value was 1.15 per cent, the maximum deviation 3 per cent. The four different observers read on an average 1.2 per cent below, 0.1 per cent above, 1.5 per cent above and 0.5 per cent below the mean of the four.

The report on reproducibility tests is to be published in the Bulletin of the Bureau of Standards. The preliminary work was reported on in the Bureau of Standards Bulletin **4**: 511. 1908; the relation between line intensity and current in same journal, **7**: 65. 1911.

ORGANIC CHEMISTRY.—*Some new compounds of the choline type.* G. A. MENGE, Hygienic Laboratory, Public Health and Marine Hospital Service. Communicated by Walter Wyman. To appear in the Journal of Biological Chemistry.

The synthetic development of compounds of the choline type has been practically limited to choline itself, the so-called homocholines (β and γ) and certain derivatives. The physiological activity of these compounds, as reported in the published work of Hunt and Taveau (Hyg. Lab. Bull. 73) is considered to indicate in a general way that the greatest activity and least toxicity is realized in those compounds which contain the trimethylamine nucleus and in which the alcoholic hydroxyl is not further removed from the nitrogen than the β position, suggesting the substitution of the α- and β-hydrogen of the carbon chain as the direction of most promising development from the standpoint of physiological activity.

It would appear that the simplest method of nomenclature for such a class of compounds is to consider them as substituted cholines, α or β according to the position of the substituted groups. The author has prepared three new choline compounds in line with the suggested development and certain of their derivatives:

α-methyl-choline, $Cl \cdot N\begin{matrix}(CH_3)_3 \\ CH \cdot CH_2OH \\ | \\ CH_3\end{matrix}$, a white, crystalline, very hygroscopic compound, was prepared by converting allyl chloride into methylethylenechlorhydrine and condensing this with trimethylamine; β-dimethyl-choline, $Cl \cdot N\begin{matrix}(CH_3)_3 \\ CH_2 \cdot COH \\ CH_3 \quad CH_3\end{matrix}$, a white, crystalline, hygroscopic compound was prepared by condensing the chlorhydrine of dimethylglycol with trimethylamine; and β-β-methyl-ethyl-choline, $Cl \cdot N\begin{matrix}(CH_3)_3 \\ CH_2 \cdot COH \\ CH_3 \quad C_2H_5\end{matrix}$, a crystalline, hygrosco-

pic compound, was prepared by condensing the chlorhydrine of methyl-ethyl-glycol with trimethylamine.

The three compounds were identified and analyzed by means of their platinum salts, which together with the gold salt of α-methyl-choline, are described. The chlorhydrines used for the disubstituted cholines were prepared from monochloracetone by means of the Grignard's reaction.

Description of the acetyl, phenyl-acetyl, benzoyl, monobrom-isocapronyl, and palmityl derivatives of α-methyl-choline and their platinum and gold salts, already prepared, is reserved for a later paper.

CHEMISTRY OF FOODS.—*Research work of the division of foods of the bureau of chemistry.* H. W. WILEY.

In the Division of Foods of the Bureau of Chemistry, some of the research work done during the past year is as follows:

Drs. W. D. Bigelow and R. F. Bacon in studying the corrosion of tin plate by canned foods have called attention to the fact that many non-acid vegetables, fish, etc., attack the lining of tin containers to an even greater extent than do the acid fruits. This kind of corrosive action on tin, which is of very great commercial importance, has not been considered heretofore and is apparently due to the nitrogenous constituents of these foods, especially amines and amino acids. Dr. Bigelow and his co-workers are continuing the study of the action of various foods on tin plate.

Drs. Bacon and Dunbar have studied the spoilage of tomatoes, detailing the chemical changes in these vegetables, together with methods for detecting the use of spoiled tomatoes in catsups, tomato sauces, etc. The same chemists have proposed an accurate and convenient method for determining malic acid in food products. This method depends on the very large increase in optical activity of this acid when treated with uranium salts. Dr. Bacon has also published during the year methods for the detection and determination of small quantities of ethyl alcohol, methyl alcohol and formic acid.

Mr. H. C. Gore has recently published a work on the processing of persimmons and on the respiration of the fruit.

M. E. Pennington has continued her investigations on the cold

storage of food products, a recent contribution having for its subject Drawn and Undrawn Poultry.

Other recent work includes Enological Studies by William B. Alwood; Estimation of Tin in Canned Goods by Herman Schreiber; and Tomato Catsup under the Microscope by B. J. Howard.

BIOCHEMISTRY.—*The colorimetric and physiological estimation of the active principle of the suprarenal gland.* WORTH HALE and ATHERTON SEIDELL, Hygienic Laboratory. Communicated by Walter Wyman. To appear in American Journal of Pharmacy.

Of the many color tests which have been proposed for the active principle of the suprarenal gland, none appears to have been developed to the accuracy required of a quantitative method. Several have been used for comparative studies on glands from different sources but, so far as shown by the literature, no attempts have been made to correlate the results obtained by color tests with the activity as determined by physiological methods.

In applying a number of the better known color reactions to a series of desiccated suprarenal glands, for the purpose of selecting a suitable one for the forthcoming revision of the U. S. Pharmacopœia, it was noticed that considerable variation in the intensities of the colors from the several samples was obtained; preliminary blood pressure experiments with some of these samples confirmed the differences indicated by the color tests. It thereupon appeared probable that a colorimetric method which would yield results in close agreement with those obtained by the physiological standardization, could be developed.

The color reaction selected was that first proposed by Krauss (Apoth. Ztg. **23**: 701. 1908) and independently described by Fränkel and Allers (Biochem. Zeitschr. **18**: 40. 1909); it consists in heating to the boiling point, a mixture of equal volumes of the aqueous suprarenalin solution and dilute (0.2 per cent) KIO_3 solution (acidifying with H_3PO_4 as proposed by Fränkel and Allers is not desirable), the reddish color being fairly permanent, and well marked even in solutions containing only 1 part of the active principle per 100,000.

Permanent color standards. It was found that the color obtained in the reaction just described consisted of a mixture of red and yellow and its tint could be accurately matched by a mixture of about 3 parts of a 1.2 per cent cobalt chloride solution strongly acidified with HCl and 1 part of similarly acidified 0.2 per cent potassium platinic chloride solution. (These solutions are described by the Committee on Standard Methods of Water Analysis.) The intensity of this permanent color standard was then adjusted to correspond exactly with that obtained by mixing 5 cc. of a 1:50,000 solution of the ash free active principle of the suprarenal, with 5 cc. of a 0.2 per cent KIO_3 solution (yielding therefore 0.1 mg. active principle per 10 cc.), heating just to the boiling point and after 15 minutes comparing with the color standard in a suitable colorimeter. After standardization, a series of test tubes were prepared with dilutions of the permanent color standard, corresponding to 0.01, 0.02, 0.03, 0.04, 0.06, 0.08 and 0.10 mg. active principle per 10 cc. of solution.

The determination of the per cent of active principle in a given sample of desiccated suprarenal is made as follows: 0.01 gm. is placed in a test-tube with 5 cc. of dilute HCl (2.5 cc. 0.1 n HCl diluted to 100 cc. with H_2O) and 5 cc. of 0.2 per cent aqueous KIO_3 solution, and the mixture heated just to the boiling point, allowed to stand 10 minutes and filtered; the color obtained is compared with the series of standards and its position determined. There may be a slight difference in the tint of the unknown solution due to yellow coloring matter extracted from the desiccated glands, but this difference has so far not been sufficient to interfere with the accurate determination of the position in the series of standards.

Determinations were made upon nine samples of desiccated suprarenal glands obtained from two firms and one sample of 1:1000 solution of the active principle which had been in the laboratory some time. The physiological activity of these same samples was determined by the blood pressure method, using as a basis for the determination the same sample of pure base which had been used to standardize the permanent color tubes required in the colorimetric method. The results are as follows.

SAMPLE NO.	PER CENT ACTIVE PRINCIPLE BY	
	Colorimetric Method	Physiological Method
362	0.6	1.0
363	0.6	1.2, 1.0, 1.0
364	0.6	1.0
365	0.8	1.1, 1.1
366	0.2	0.3, 0.2+
367	0.8	1.1, 1.0, 1.1
368	0.4	0.7
369	0.4	0.7
370	less than 0.03	0.04
1:1000 solution	0.03	0.035

From this table it will be seen that fairly large differences exist in the two sets of values; however, it will be noted that a close parallelism exists between them. The results by the physiological method are some 30 per cent higher in most cases. We are unable at present to account for this but believe that the small amount of yellowish extractive material yielded by the samples is the cause of the lower readings by the colorimetric method. In spite of these variations, however, this test appears to be by far the most satisfactory one at present available and furnishes a means for closely estimating the relative value of different lots of desiccated suprarenal glands and 1:1000 solutions of the active principle. We hope to be able in the near future to extend our experiments to many other samples, both of the desiccated glands and the commercial 1 to 1000 solutions and trust that we will be able to remedy the cause of the present differences in values obtained by the two methods.

In conclusion special attention should be called to the very wide differences in activity found for the various commercial samples of desiccated glands and the considerable diminution in strength of a 1:1000 solution of the active principle. Such wide variations have not so far been reported for the commercial glands and were not expected when we undertook these experiments. They illustrate very forcibly the need of just such a simple method of control of this product as is described in the present paper.

PLANT PHYSIOLOGY.—*The wilting coefficient for different plants and its indirect determination.*[1] LYMAN J. BRIGGS and H. L. SHANTZ. To appear in Bulletin 230, Bureau of Plant Industry.

The object of this investigation was to determine the extent of the variation exhibited by different plants with respect to the minimum point to which they can reduce the moisture content of the soil before permanent wilting occurs. It has heretofore been believed that plants differ widely in this respect and that drought resistance is in part due to the additional supply of water which is available to some plants thru the greater force which they exert upon the soil moisture. The results of this investigation have led us to conclude that the differences exhibited by plants in this respect are much less than have heretofore been supposed, and are so small as to be of no practical utility from the standpoint of drought resistance. As compared with the great range in the wilting coefficients, the small differences arising from the use of different species of plants in determining the wilting coefficient become almost insignificant.

The moisture content of the soil corresponding to the wilting of a plant growing in a confined soil mass is usually spoken of as non-available moisture. We have found that plants are capable of reducing the moisture content of the soil far below that corresponding to the wilting point, and that a steady loss of moisture goes on through the plant tissues even after the death of the plant. The moisture content at the wilting point can not then be considered as non-available, and we have adopted the term wilting coefficient as expressing more specifically the moisture content of the soil corresponding to the permanent wilting of the plant.

The *wilting coefficient* is then defined as the moisture content of the soil (expressed as a percentage of the dry weight) at the time when the leaves of the plant growing in that soil first undergoes a permanent reduction in the moisture content as the result

[1] Presented before the Botanical Society of Washington, October 9, 1911, and before the Philosophical Society of Washington, October 14, 1911.

of a deficiency in the soil moisture supply. By a permanent reduction in the moisture content is meant a condition from which the leaves can not recover in an approximately saturated atmosphere without the addition of water to the soil. In the case of most plants, wilting accompanies the reduction of the water content of the leaves, and is the criterion used to determine the wilting coefficient of a soil for that plant. The definition, as stated, is applicable also to those plants which, owing to structural peculiarities, do not give visible evidence of a reduction of the moisture content of the leaves. The wilting coefficient for such plants is determined by means of the balancing method.

In making wilting coefficient determinations the following precautions are necessary:

1. The soil used should be as uniform as possible.
2. The soil should be brought to a uniform water content before being used.
3. All loss of water should be prevented except that due to the transpiration of the plant.
4. All sudden fluctuations in temperature should be avoided.
5. The moisture determination should be made as soon as the plant has first reached a wilted condition from which it can not recover when placed in a damp chamber.

The method employed consists in growing the plants in a small glass pot, evaporation from the soil surface being prevented by means of a seal of wax which is melted and flowed over the soil surface. In the case of monocotyledons, this wax seal can be applied immediately after planting the seeds, and *the seedlings will grow readily through the wax*, which forms a perfect seal around the stems. In the case of dicotyledons, the wax, which is usually a mixture of paraffin and petrolatum having a low melting point and low heat conductivity, can be melted and flowed around the stems of the seedlings without injury. During growth, the pots are kept immersed in a water bath to avoid condensation of the soil moisture on the pot walls.

When the precautions noted above are observed, the probable error of the mean of the determinations from twelve pots does

not usually exceed one part in a hundred, which is comparable with the accuracy with which the moisture retentiveness of the soil used can be determined by purely physical methods.

The wax seal method is also particularly adapted to the study of transpiration, since all loss of water is avoided except that taking place through the plant.

Wilting coefficient determinations have been made in a series of twenty soils, ranging from sands to clays. In this work, involving about 1300 determinations, a large number of varieties of the different crop plants have been tested, as well as many native plants from the Great Plains.

The results obtained show that species differ only slightly as regards the soil moisture content at which permanent wilting first takes place. Taking 100 to represent the average wilting coefficient, the different species tested give an extreme range (excepting *Colocasia* and *Isoetes*) from 92 for Japan rice to 106 for a variety of corn. Most of the species and varieties tested differ much less than this. On the same scale, the great crop plants gave the following values, obtained by combining the different varieties: corn, 103; wheat, 99; oats, 99; sorgo, 98; millet, 97; barley, 97; rye (one variety only) 94; rice, 94; grasses, 97; legumes, 101.

We are, then, led to conclude that the differences exhibited by crop plants, in their ability to reduce the moisture content of the soil before wilting occurs, are so slight as to be without practical significance in the selection of crops for semi-arid regions. Furthermore, we believe that the slight differences which we have observed are largely due, not to the ability of one variety to exert a greater tractive force upon the soil moisture than another, but to the more perfect root distribution of one variety as compared with another. Drought resistance in certain plants cannot, then, be attributed to their ability to exert a greater force upon the soil moisture, and so gain an additional water supply.

A series of comparisons have also been made of the relative time of wilting of different plants grown together in the same pot. In practically every case, wilting occurred simultaneously, which is in harmony with the above conclusions.

A balancing method has been developed for determining the wilting coefficient for plants in which wilting is difficult to observe, owing to structural peculiarities. The plant is potted in a glazed pot and the soil surface sealed with wax as before. The potted plant is then mounted horizontally in a frame balanced on knife edges. The water transpired by the plant is at first replaced from the supply in the soil. During this time the soil end of the system tends to move upward, owing to the loss of water, and is kept balanced by adjusting a counterpoise. A short period then occurs during which the water lost thru transpiration is supplied both from the soil and from the storage tissues of the plant. During this time the system appears sluggish. Finally the amount supplied from the soil is insufficient to offset the increasing amount lost from the storage tissues of the plant, and the direction of motion of the system is reversed, the plant moving upward. The soil moisture content at this time corresponds to the wilting coefficient of that soil for the particular plant used, since the loss of water from the plant tissues would be accompanied by wilting, except for structural peculiarities.

We have shown by this method that the olive and *Opuntia* undergo a reduction in the moisture content of their aerial parts at the time other plants wilt, altho no outward evidence of such loss is apparent.

That part of the soil moisture content that is available for plant growth is represented by the difference between the actual water content and the wilting coefficient. The latter determination is consequently essential in any critical study of the relation of plant growth to soil moisture. The desirability of a rapid determination of the wilting coefficient in connection with field work led to an investigation to determine whether it could be computed from physical measurements of the moisture retentivity of the soil. A comparison of the wilting coefficient has been made with the moisture equivalent, hygroscopic coefficient, moisture holding capacity, and the mechanical analysis (all expressed in percent), using a series of soils ranging from sand to clay. From this comparison a series of linear relationships have been established as expressed in the following equations, which thus provide

a means of computing the wilting coefficient when direct determinations are not feasible.

$$\text{Wilting coefficient} = \frac{\text{Moisture equivalent}}{1.84\,(1 \pm 0.007)}$$

$$\text{Wilting coefficient} = \frac{\text{Hygroscopic coefficient}}{0.68\,(1 \pm 0.018)}$$

$$\text{Wilting coefficient} = \frac{\text{Moisture holding capacity} - 21}{2.90\,(1 \pm 0.021)}$$

$$\text{Wilting coefficient} = \frac{0.01\,\text{sand} - 0.12\,\text{silt} - 0.57\,\text{clay}}{(1 \pm 0.025)}$$

The second term of the quantity within the brackets shows the probable error of the relationship in each case and constitutes a measure of the relative accuracy of the different methods.

The moisture equivalent method, in which the measurements are made with the aid of the centrifugal machine exerting a force 1000 times that of gravity, is the most accurate and satisfactory of the indirect methods.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

METEOROLOGY.—*Variations of temperature at summit and base stations in the central Rocky Mountain region.* ALFRED J. HENRY. Bulletin of the Mount Weather Observatory, **4**: 103-116. 1911.

In this and a previous paper the author discusses the temperatures at summit and base stations in the high Rocky Mountain region of eastern Colorado, as recorded simultaneously by Richard thermographs, the latter being controlled by eye readings of standard mercurial thermometers.

It is shown that as a rule, the course of the temperature at both levels is very nearly parallel, that the accidental changes occur nearly simultaneously, with the exception that changes to warmer weather set in at the upper station earlier than on lower levels, that while the course of the temperature at both levels is generally similarly directed, there are times when it is oppositely directed, as when the temperature rises on the mountain summits and falls on the plains to the eastward. Such instances indicate that the temperature control is occasionally shifted from one side of the mountain to the other and that the mountains then become a real climatic barrier. Ordinarily they offer little or no hindrance to the movement of atmospheric disturbances on which temperature changes depend. In the cold season when the Great Basin is occupied by an area of high pressure the latter seems to dominate the winds and temperature on the higher mountain summits of Colorado and New Mexico but not the plains to the eastward.

The dependence of temperature on altitude is discussed for the pair of stations, Fraser, in Middle Park, Colorado, altitude 2,609 meters, 8,560 feet, and Corona, the latter on the summit of the continental divide, altitude 3,554 meters, 11,660 feet. Although Fraser is 945 meters, 3,100 feet, lower than Corona, it has a temperature that during the night hours and under certain weather conditions is considerably lower than that of Corona notwithstanding the difference in altitude. The cause of the abnormally low temperatures observed at Fraser are

ascribed to the surrounding topography which favors the drainage of cold air down the mountain sides and its accumulation on the valley floor, since there is no easy means of escape. Nocturnal cooling is also at a maximum in the clear dry air of Colorado and it seems to be accentuated under certain types of pressure distribution which prevail over Wyoming and Idaho during the cold season. A. J. H.

PHYSICS.—*Selective radiation from various substances III.* W. W. COBLENTZ. Bulletin Bureau of Standards, Reprint 156. 1911.

The present paper is a continuation of previous work (Bur. Bull. Standards, Reprints 97 and 131) on this subject. The selective emission and absorption of the acetylene flame is investigated spectroradiometrically; also the selective emission of the Welsbach mantle, and of the same material formed into a solid rod which was heated to incandescence electrically.

The conclusions arrived at from the results of the experiments and from historical inquiry are that the selective emission can be explained on a purely thermal basis without invoking the hypothetical and unproven assumption of the presence of "luminescence" and of catalysis.

W. W. C.

PHYSICAL CHEMISTRY.—*Radiometric investigation of water of crystallization, infra-red absorption screens and standard spectral lines.* W. W. COBLENTZ. Bulletin Bureau of Standards, Reprint 168. 1911. Journal Franklin Institute, October. 1911.

This is a continuation of previous investigations of the condition of water in minerals (Bull. Bur. Standards, Reprint 45). The infra-red transmission of tremolite and of opal are examined *in extenso;* the latter after various stages of de- and rehydration. The spectroradiometric analysis shows no distinction between "water of crystallization," "absorbed water," and "water of solid solution;" all showing the absorption bands of water in its free liquid state. Tremolite is supposed to contain dissolved water but the radiometric test, although sufficiently sensitive for the purpose, failed to detect it. A group of miscellaneous substances is described including gelatin, in which the moisture appears to be present as "water of constitution." W. W. C.

CHEMISTRY.—*The determination of total sulphur in india rubber.* C. E. WATERS and J. B. TUTTLE. Journal of Industrial and Engineering Chemistry, **3**: 734. 1911. Bulletin Bureau of Standards, **8**: No. 2. 1911.

A comparative study of different methods already published and of variations of these methods. The procedure finally adopted was essentially that of Henriques, except that the nitric acid used to decompose the rubber is saturated with bromine to ensure complete oxidation of free sulphur to sulphuric acid. The methods were tested by using a large uniform sample of rubber, as well as pure sulphur and a solution of sulphuric acid of known strength. C. E. W.

GEOLOGY.—*The Mount McKinley region, Alaska.* ALFRED H. BROOKS. *With description of the igneous rocks and the Bonnifield and Kantishna districts.* L. M. PRINDLE. Professional Paper U. S. Geological Survey No. 70. Pp. 234, with maps, sections, and views. 1911.

The Mount McKinley region is blocked out by the meridians 148° and 154° and parallels 61° and 65° 20′ north, but the Alaska Range, which traverses the central part of this region is more specially here under consideration. The Alaska Range is a belt of rugged mountains trending northeast and east 50 to 60 miles wide and from 500 to 600 miles long, of which Mount McKinley (20,300 ft.) is the highest peak. This range was practically unexplored until 1902, when most of the data were collected on which the following conclusions are based.

Undifferentiated Paleozoic sediments, unconformably overlaid by a great complex of volcanic, probably Jurassic, rocks (Skwentna group), and these in turn unconformably succeeded by Middle Jurassic sediments (Tordrillo formation), occur in the eastern part of the range. These rocks dip toward the axis of the range and form the eastern arm of a broad synclinorium. In the western arm the Tordrillo formation rests unconformably on a great series of Paleozoics which has been subdivided into (1) Tatina group (Ordovician), (2) Tonzona group (Silurian or Devonian [?]), (3) Middle Devonian limestone, (4) Cantwell formation (Carboniferous [?]). The last, which rests unconformably on the older rocks, has only been recognized in the northern part of the range. Complex folding and profound faulting have taken place along the inland (northern) front of the range, and in this some Kenai beds (Eocene) are involved. Numerous stocks and dikes of granites, diorites, and related rocks, probably of late Jurassic age, occur in the

Alaska Range, and diabase dikes, probably of Eocene age, are not uncommon. Along the northern margin of the range the oldest recognized Paleozoics rest unconformably on complexly folded metamorphoric sediments (Birch Creek schists). Still farther north these metamorphic schists are succeeded by a great thickness of Paleozoics only in part subdivided and correlated with the formations described above. The Mesozoic horizons of the Alaska Range have in part been recognized in the Matanuska Valley of the eastern part of the McKinley region.

An extensive river system was developed in this region during Eocene times, and in this the sediments classed as Kenai were deposited. The northern part of the province was peneplaned in later Tertiary times and it is possible also that the same period of erosion may have baseleveled the southern part of the province. Uplift followed and the modern stream valleys were in part developed along the old Tertiary drainage system. A. H. B.

GEOLOGY.—*Denudation and erosion of the southern Appalachian region and the Monongahela Basin.* LEONIDAS CHALMERS GLENN. Professional Paper U. S. Geological Survey No. 72. Pp. 137, with maps and views. 1911.

Two kinds of aqueous erosion are recognized, namely, (1) stream erosion, confined to the water courses, and (2) general surface erosion, over the whole drainage basin. Stream erosion is continuous but varies greatly in intensity with the amount of water. General surface erosion is due almost entirely to the rain. During heavy rainfall a grass sod absorbs less water than a good humous cover in forested areas and the run-off from grass-land is greater than from forest. The force of the rain drop is lessened in forested areas, and as the fallen drops gather to flow down the slopes they are checked by the leaves and litter or are absorbed by the spongy mass of soft moss or turf. The protective effect of forest cover was noted in many parts of the region. In the course of ages there has come about, in all but a very small part of the area, such an adjustment between the steepness of the forested slope and the average rainfall and other erosive agencies that the wasting of the slope is reduced to a minimum. Streams that flow from such forest-clad graded slopes rise more slowly during rains than similar streams in cleared areas; they also continue longer in flood and subside more slowly. Removal of the forest disturbs the natural equilibrium, excessive erosion takes place, the soil is swept away, and the mountain slopes are scarred.

Other things being equal, the extent and character of erosion varies with the bed-rock. The nature of the rock determines the character of the soil and this determines the kind and rate of erosion.

A. H. BROOKS.

GEOLOGY.—*Geologic Atlas of the United States. Folio No. 177. Bargettstown-Carnegie folio, Penn.* E. W. SHAW and M. J. MUNN. U. S. Geological Survey. Pp. 11, with maps and sections. 1911. *Oil and gas fields of the Carnegie Quadrangle, Penn.* M. J. MUNN. Bulletin U. S. Geological Survey No. 156. Pp. 99, with maps and sections.

The outcropping rocks belong to the Conemaugh, Monongahela, and Greene formations of the Carboniferous system and consist of shale, sandstone, and limestone with minor amounts of coal and clay. Beneath the surface are similar rocks of Allegheny, Pottsville, and Pocono age, and even older rocks have been reached by the drill. The beds dip gently south but the structure is modified by minor irregularities.

Almost all the coal produced is taken from a bed known as Pittsburg coal. This coal outcrops extensively, but in general it is below the surface in the southern half of the district and up near the tops of the hills in the northern half. A few feet above this coal is another bed three or four feet thick known as the Pittsburg rider which is mined to some extent. The oil and gas are found in sandstones 1000 to 2000 feet below the surface, belonging mostly in the Pottsville and Pocono formations.

Two surface features of especial interest are: (1) heavily gravel-covered terraces in the larger valleys of the region lying 200 to 300 feet above present streams and (2) a symmetry in the minor drainage lines of the region, the small tributaries flowing southeast being much longer than those flowing in an opposite direction. E. W. S.

GEOLOGY.—*Geology and underground waters of southern Minnesota.* C. W. HALL. E. O. MEINZER, and M. L. FULLER. Water-Supply Paper U. S. Geological Survey No. 256. Pp. 406, with maps and sections. 1911.

The region here described includes approximately the southern two-fifths of the State of Minnesota and has an area of 28,265 square miles.

Five great rock divisions occur in southern Minnesota. In the order of age, these are the Archean, Algonkian, Paleozoic (here including the Cambrian, Ordovician, and Devonian systems), Cretaceous, and Quaternary. Tertiary stream deposits doubtless exist in some localities,

but they are so unimportant that they have not been differentiated and are here considered with the Quaternary.

In the northwestern and the north-central parts of the area the Archean system, consisting of granite and allied crystallines, outcrops in a number of localities and everywhere lies within a few hundred feet of the surface, but toward the south and east it slopes downward abruptly and is found only at considerable depths. In the southwest the Sioux quartzite, which is of Algonkian age, projects up through younger formations and appears at the surface at numerous localities.

In the east and south, where the granite is far below the surface, it is overlain by a succession of indurated sandstones, shales, and limestones, aggregating many hundreds of feet in thickness, at least the upper part being of Paleozoic age. Throughout most of the western part, and probably in isolated areas of the eastern part, of southern Minnesota, Archean, Algonkian, and Paleozoic rocks are covered by Cretaceous deposits consisting of soft, plastic shales and incoherent sandstones which together attain a maximum thickness of at least 500 feet, though they are generally much thinner. A mantle of glacial drift is spread out over all these formations and, with the exception of the alluvium recently formed in stream valleys, is the youngest deposit in the region.

In regard to their importance in furnishing water supplies, the Pleistocene ranks first and the Paleozoic second, while the Cretaceous and Algonkian are of minor value, and the Archean is virtually destitute of available supplies, everywhere marking the lower limit of water horizons. H. D. McCaskey.

ECONOMIC GEOLOGY.—*The Lander and Salt Creek Oil Fields Wyoming: The Lander oil field, Fremont County.* E. G. Woodruff. *The Salt Creek oil field, Natrona County.* C. H. Wegemann. Bulletin U. S. Geological Survey No. 452. Pp. 87, with maps, sections, and views. 1911.

Viewed as a whole the Lander oil field consists of a central highly dissected ridge with moderately-trenched slightly-undulating plains on either side. The topographic expression of the field is believed to have resulted from the erosion of a plain composed of loose material that once covered the area at a much higher altitude than the present surface and sloped northwestward from the mountains toward the interior of the Wind River Basin.

The strata exposed at the surface in this field belong to the Triassic (?), Jurassic, Cretaceous, Tertiary and Quaternary systems. Below

the Triassic (?) are rocks of Permian (?) and Pennsylvanian age, which do not outcrop in the field but are exposed on the slope of Wind River Mountains. They are entered by some of the oil wells and are believed to be the source of most, if not all, of the oil.

The Triassic (?) is represented by the Chugwater formation, the Jurassic by the Sundance and Morrison formations, and the Upper Cretaceous by the Dakota sandstone, Mancos shale, and the Mesaverde formation. An unconformity separates the Wind River formation (Eocene) from the Upper Cretaceous rocks. The formations, including from the Chugwater to the top of the Upper Cretaceous, aggregates nearly 9500 feet in thickness.

The structural province in which this field lies comprises very broad synclinal basins bordered by relatively high narrow mountain ranges with small steep-sided, slightly elevated anticlines that are exposed about the edges of the basins in a zone between the basins proper and the mountains. If the strata in the interior of the basins are folded, the folds are concealed beneath beds which were deposited subsequent to the major structural movements in the province.

The Salt Creek oil field lies in the northeast corner of Natrona County, Wyoming, and in the drainage basin of Powder River. Topographically the region includes broad flat-topped interstream areas, separated by broad flat valleys. Scarps representing the outcropping edges of hard strata are plentiful. The geologic sequence includes about 6,800 feet of Upper Cretaceous strata, divided into 13 formations. In addition to these, there are the Morrison formation of Jurassic age (?), the Lance formation, which is Tertiary or Cretaceous, and the Fort Union, which is Eocene.

A broad anticlinal arch, more or less faulted, crosses the field in a northwest-southeast direction, the limits of which dip at angles of from 8° to 29°. The steepest dips are found on the west side of the arch. Within this anticline are two domes. To the west of this arch is a second anticline of similar character. The oil occurs at or near the crest of the anticline. A. H. Brooks.

PETROLOGY.—*Geology of the pegmatites and associated rocks of Maine, including feldspar, quartz, mica, and gem deposits.* Edson S. Bastin. Bulletin U. S. Geological Survey No. 445. Pp. 152. Illustrated. 1911.

The commercially important pegmatite deposits are principally in the southern and western parts of Maine. Most of the pegmatites are distinctly intrusive into the surrounding schists and granites. They

differ greatly in coarseness but have the common distinguishing characteristic of extreme irregularity of grain. They commonly form long, narrow lenses lying parallel with the foliation of the schists. The associated foliated rocks, which are of unknown age, are in part of igneous and in part of sedimentary origin. The granite and pegmatite are mineralogically similar and numerous observed transitions from one into the other, show that the two are in a broad way contemporaneous and are genetically related.

The pegmatite deposits are essentially coarse granites, their principal light-colored constituents being potash and soda feldspars, quartz, and muscovite, and their principal dark-colored constituents biotite and black tourmaline. Accessory constituents present in almost all pegmatites are garnet, magnetite, and green opaque beryl. Accessory minerals present only in certain pegmatites number over fifty species, the most important probably being lepidolite, emblygonite, spodumene, tourmaline, beryl, topaz, and rose or amethystine quartz. Variations through increase in the sodium and lithium content are responsible for most of the gem deposits of the State.

External conditions, though locally having some slight influence, are not primarily the cause of the pegmatitic textures. The presence of the rarer elements also seems to have had only a minor influence on the texture. Theoretical considerations and the presence of miarolitic cavities in certain pegmatites point to the presence of gaseous constituents in the magmas, especially water vapor, as the primary cause of their textures.

There are many facts which suggest that the difference in average composition between the granite pegmatites and the normal granites was relatively slight and that the pegmatite magmas were not so different in physical characters from the granite magmas as has been commonly supposed.

The theory that the graphic intergrowths in pegmatites represent eutectic mixtures can not be regarded as proved.

Field relations suggest that the large areas characterized by particular abundance of pegmatite intrusions correspond to the roofs of granite batholiths. E. S. B.

BIOLOGY.—*Development of sponges from dissociated tissue cells.* H. V. Wilson. Bulletin U. S. Bureau of Fisheries, **29**: 1-30, pl. i–v. 1911.

Sponges were cut into small pieces and strained thru fine bolting cloth into a dish containing water. The cells settle to the bottom as a fine

sediment, but immediately begin to fuse into conglomerate masses, which in turn unite and metamorphose until the sponge is eventually restored.

The experiments were made chiefly with *Microciona prolifera*, which it was shown can be perfectly regenerated by this method of growth from dissociated cells. *Lissodendoryx carolinensis* is less hardy, and it proved difficult to dissociate the cells in healthy condition, but the behavior of the tissue was the same as in *Microciona*. In *Stylotella heliophila* the behavior of the tissue was slow and feeble as compared with *Microciona*, but the plasmodial masses were formed. In neither of the latter two species, however, did the plasmodial masses metamorphose.

Intermingling of the red tissue of *Microciona* with the bright green of *Lissodendoryx* failed to produce fusion of the different species, as did also the intermingling of tissue of *Microciona* and *Stylotella*.

E. M. SMITH.

FISHERIES.—*Effects of explosive sounds, such as those produced by motor boats and gunshots, upon fishes.* G. H. PARKER. Bureau of Fisheries Document No. 752. Pp. 9. October, 1911.

To the human ear, when the listener is under water, the noise of motor boats and the sound of gunshots, even at very close range, are very slight. Testing fishes in enclosures with the same kinds of sounds the following conclusions were reached:

The sounds produced by motor boats are extremely faint under water and have little influence on the movements and feeding of fishes. Such influence as they do have is temporary and very much restricted in local extent.

Single explosive sounds, like the report of a gun, may startle fish and cause them to cease feeding, but these responses are also temporary and local.

Altho most sounds are repellent to fish, some may serve as lures to particular species. E. M. SMITH.

PLANT PATHOLOGY.—*The rusts of grains in the United States.* E. M. FREEMAN AND EDWARD C. JOHNSON, Bureau of Plant Industry, Bulletin 216. Pp. 87, pls. 1. 1911.

This paper embodies results of a detailed study of the grain rusts with regard to distribution, relationships, physiology, and life history. Particular attention is directed to "biologic forms" of rusts, vitality of successive uredo generations, wintering of the uredo generation, climatology in relation to rust epidemics, and methods of breeding grains for rust resistance. Some of the more important conclusions derived follow:

The so-called stem rusts of wheat, barley, rye, and oats are undoubtedly "biologic forms" of the same species, *Puccinia graminis* Pers., and though many of them are highly specialized an interchange of hosts may often be induced by special cultural methods. By gradual variation and adaptation to varying conditions, a rust species widely distributed may form a number of strains or types differing in physiological reactions.

In successive cultures of the uredospores of six different grain rusts, the fifty-second generation was apparently as vigorous as the first in spite of the absence of the aecidium during this period, no "invigoration" having been necessary for this length of time. The uredo of several of the rusts may survive the winter in latitudes as far north as St. Paul, Minn. Rust spores may be carried from one region to another for hundreds of miles by winds and upper air currents.

Subnormal temperatures, delaying and lengthening the heading and early flowering of period the wheat and furnishing conditions most favorable for spore germination and infection, are believed to have been an important factor, if not the determining factor, for the stem rust epidemic of 1904 in the Middle Northwest.

For the prevention of rusts fungicides and soil treatments, as a rule, have proven ineffective, and the only practical method known is the production of rust-resistant varieties through hybridization and selection. To what character resistance is due is not clearly understood. Resistance and susceptibility in cereals, however, are inheritable characters, apparently occurring in Mendelian proportions. In breeding cereals for resistance, the rust must be present in the breeding plants every year. To insure this special methods of rust propagation must be employed. E. C. J.

PLANT PATHOLOGY.—*Timothy rust in the United States.* EDWARD C. JOHNSON, Bureau of Plant Industry, Bulletin 224. Pp. 20. 1911.

Timothy rust was reported from Wisconsin in 1882. There is some doubt concerning the accuracy of this report. It was reported from Iowa in 1891. From 1891 to 1906 no mention of the parasite has been found. In 1906, the rust became epidemic at the Arlington Experimental Farm and since then has been found from Maine to Minnesota, and south to Iowa, Kentucky and Virginia.

Rust on timothy is similar to *Puccinia graminis* Pers. on wheat. Experimental results demonstrate its identity with the rust on timothy in Europe. The aecidial stage is not definitely known. Early indica-

tions that the barberry may be the aecidial host in Europe have not been substantiated. For this reason and because of many other more or less distinctive characteristics of this rust the writer favors the use of the specific name Puccinia Phlei-pratensis Erikss and Henn.

The rust mycelium survives the winter at the Arlington Experimental Farm, producing fresh uredospores in the spring. Its distribution is undoubtedly due to dissemination of the uredospore by the usual agencies, namely, insects, birds, man, other animals, surface winds and upper air currents. Its further distribution is to be expected.

The resistance of varieties of timothy to rust varies greatly. Dependable data on this point can be secured only under epidemic conditions. Breeding of rust-resistant varieties of timothy is the only known method of preventing the disease. This may not be as difficult as it appears at first as timothies thus far have not been highly bred. Varietal differences and variations, therefore, are many, giving promise of marked response to selection. E. C. J.

PLANT PATHOLOGY.—*The blister rust of white pine.* PERLEY SPAULDING, Bureau of Plant Industry, Bulletin 206. Pp. 88. July 22, 1911.

As a result of the active and increasing reforestation movement in the northeastern States, white pine nursery stock has been imported from Europe in considerable quantities for a number of years. Small quantities of such stock have been imported for a much longer time. The white pine is attacked in Europe by the fungus *Peridermium strobi*, which is its most serious enemy in Europe, causing very serious loss in nurseries and young plantations. The fungus is widely spread in Europe and has been proved to be one stage of *Cronartium ribicola*, which occurs on currant and gooseberry leaves. The disease also has attacked *Pinus cembra*, *P. lambertiana*, and *P. monticola*. It also probably has attacked *P. excelsa*. Early in 1909 it was discovered that this disease had been imported extensively into the northeastern States upon young white pine seedlings imported from Germany. Nearly all of the diseased stock has been sent to this country by a single nursery, namely, J. Heins Sons of Halstenbek. As soon as the presence of this disease was known, the various State officials met and agreed to endeavor to prevent it from obtaining a foothold in this country. This has involved repeated inspections of the plantations of diseased white pines and the removal of the species of *Ribes* in the neighborhood of these plantations. Up to the present time the disease is not known to have become established here. Owing to the great danger from importations of white

pine from Europe, the import trade in this stock since 1909 has been reduced to a small amount. In the years 1910 and 1911 only a very few shipments are known to have come into the country from the above mentioned nursery. Diseased shipments have, however, been received from three French firms, thus showing the danger from importations from any European country. The disease has an incubation period during which it cannot be detected by the most skilful plant pathologist. Because of this incubation period, which is of indefinite length, the only feasible plan of handling the situation seems to be the prohibition of the importation of white pine, and of other five-leaved pines, which, so far as we know, are also susceptible to the disease. P. S.

ENTOMOLOGY.—*Descriptions of Tineoid moths (Microlepidoptera) from South America.* AUGUST BUSCK. Proceedings U. S. National Museum, **41**: 205–230. Plates 8–9. 1911.

The material is from the collection of Mr. Wm. Schaus and almost wholly from French Guiana. Forty-five species and the following five new genera are described:

Filinota, related to *Carcina; Hasta*, allied to *Anchinia; Gonada*, near *Necedes; Ordrupia*, similar to *Hemerophila;* and *Plumana*, based on a male much like *Fumea*. Twenty-three of the new species are in the genus *Stenoma*. The plates are photographs and do not well illustrate the moths. N. BANKS.

ENTOMOLOGY.—*Bees in the collection of the U. S. National Museum.* T. D. A. COCKERELL. No. 1. Proceedings U. S. National Museum, **39**: 635–658. 1911. No. 2. Ibid., **40**: 241–264. 1911.

In these two papers Professor Cockerell describes new species of bees from the United States and Oriental Asia. There are notes of value on many of the described species and frequently closely allied forms are separated by synoptic tables. In the second paper there is a table to the Asiatic species of *Anthophora*. There are no new generic names but new characters are given to distinguish *Viereckella* from *Melanonomada*, both really subgenera of Nomada. N. BANKS.

ENTOMOLOGY.—*Notes on the distribution of millipedes in Southern Texas, with descriptions of new genera and species from Texas, Arizona, Mexico, and Costa Rica.* O. F. COOK. Proceedings U. S. National Museum, **40**: 147–167. 1911.

In the isolated humid spots, now containing certain peculiar millipedes, the author sees evidence of the existence of former forests in

South Texas. *Eurelus* and *Anelus* are the new genera from Texas; three new species of *Onychelus* are described from Arizona, one from the nest of a wood-rat. He also describes from Central America two other two new genera; *Glosselus*, related to *Anelus*, and Centrelus, closely allied to *Eurelus*. One misses the figures that are so useful in papers on myriopods. N. BANKS.

ENTOMOLOGY.—*Descriptions of new Hymenoptera.* 3 parts. J. C. CRAWFORD. Proceedings U. S. National Museum, **39**: 617, 623; **40**: 439–449; **41**: 267–282. 1911.

Forty-six new species are described from various parts of the world, mostly in the Chalcidae and Proctotrypidae, a few are bees. The following new genera are erected; *Dipachystigma*, *Winnemana*, *Sophencyrtus*, *Leurocerus*, and *Agiommatus*. A table is given for the West Indian species of *Horismenus*. Figures of wings or antennae are given for a few forms which are very useful in identification. The collectors are remembered in the specific appellations. N. BANKS.

ENTOMOLOGY.—*Notes on insects of the order Strepsiptera, with descriptions of new species.* W. D. PIERCE. Proceedings U. S. National Museum, **40**: 487–511. 1911.

This is supplementary to the author's "Monographic Revision" of the order. Twenty-four new species are described, and the following new generic names: *Triozocera, Belonogastechthous, Tachytixenos, Diozocera, Pentozocera, Pentozoe;* three of these are emendations and so synonyms. A host-list is appended giving many new records.

N. BANKS.

ENTOMOLOGY.—*On some Hymenopterous insects from the island of Formosa.* S. A. ROHWER. Proceedings U. S. National Museum, **39**: 477–485. 1911.

A list of nineteen species captured at Horisha by Mr. T. Fukai, of which nine are described as new; no new genera. N. BANKS.

ENTOMOLOGY.—*The color of the light emitted by lampyridae.* W. W. COBLENTZ. The Canadian Entomologist, p. 355, October. 1911. Phys. Zeitschrift, October. 1911.

The light of various species of fire-flies and of a standard lamp were photographed, and the densities compared by means of spectrophotographic photometry. In this manner the spectral energy curve of the

light of the fire-fly was deduced from a knowledge of the spectral energy curve of the standard lamp. It is shown that the color of the light is not a subjective phenomenon, the maximum emission of the *Pyrophorus noctilucus* being at 0.538μ; *Photuris pennsylvanica* being at 0.552μ; *Photinus pyralis* being at 0.567μ; *Photinus consanguineus* being at 0.578μ.

W. W. C.

PSYCHOPATHOLOGY.—*Occupations neuroses (writer's cramp, etc.) recovery after psycho-analytpic measures followed by reëducation.* TOM A. WILLIAMS. Washington Medical Annals. January, 1911. Monthly Cyclopaedia. July, 1911.

The true professional neurosis is psychogenically perpetuated, even though it may have been at first produced by a physical disability. To show this five cases are studied. They are: (1) A right torticolis and cramp of the right arm while counting money. The pathogenesis was traced to an unpleasant incident with a fellow employee who sat behind and to the right while they were counting money in the treasury. The patient's impatience interrupted the great improvement. (2) Writer's cramp in a bank-teller, who refused treatment and had to change occupation. (3) Tremulous writers cramp in a paymaster, which was traced through a psychological mechanism in one interview, which lead to recovery after one month, which persists two and a half years later. (4) Writer's cramp in a woman who always hated correspondence. Cured in four months after unveiling psychological mechanism. (5) Complex multiple cramps in a psychasthenic woman of thirty. After persevering psychoanalysis and arduous education for six months, the patient recovered the power of writing with the right hand.

In no case was a sexual factor found in the genesis. Treatment, after psychoanalysis, consisted of explanation of the mechanism until the patients themselves could expound it: following which psychomotor discipline preceded the reëducation of the professional act. T. A. W.

PROGRAMS AND ANNOUNCEMENTS

PHILOSOPHICAL SOCIETY

700th Meeting, November 25, 1911, Cosmos Club at 8.30. Address of the retiring President. ARTHUR L. DAY: *Geophysical Research.*

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